

Practical Evaluation of High-Efficiency Si-based Tandem Solar Cells

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Abstract : Si-based double-junction tandem solar cells have become a popular research topic because of the advantages of low manufacturing cost and high energy conversion efficiency. However, there is no set of calculations to select the appropriate top cell materials. Therefore, this paper will propose a simple but practical selection method. First of all, we calculate the S-Q limit and explain the reasons for developing tandem solar cells. Secondly, we calculate the theoretical energy conversion efficiency of the double-junction tandem solar cells while combining the commercial monocrystalline Si and materials' practical efficiency to consider the actual situation. Finally, we conservatively conclude that if considering 75% performance of the theoretical energy conversion efficiency of the top cell, the suitable bandgap energy range will fall between 1.38eV to 2.5eV. Besides, we also briefly describe some improvements of several proper materials, CZTS, CdSe, Cu₂O, ZnTe, and CdS, hoping that future research can select and manufacture high-efficiency Si-based tandem solar cells based on this paper successfully. Most importantly, our calculation method is not limited to silicon solely. If other materials' performances match or surpass silicon's ability in the future, researchers can also apply this set of deduction processes.

Keywords : high-efficiency solar cells, material selection, Si-based double-junction solar cells, Tandem solar cells, photovoltaics.

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